

FILE COPY

Express Mail No. EL 451 596 455 US First Class Mail ()
Date Mailed March 26, 2001
Ser. No. To be assigned Filed herewith
Inventor Chung et al.
For INCLUSION OF NITROGEN AT THE SILICON DIOXIDE-SILICON CARBIDE
INTERFACE FOR PASSIVATION OF INTERFACE DEFECTS

() Affidavit/Declaration	() Fee Address Indication Form
() Amendment	(X) Fee Calculation Utility Patent (dupl)
(X) Application <u>16</u> Pages	() Issue Fee Transmittal
(X) <u>26</u> Claims <u>6</u> Drawings (sheets)	() Letter
() Appeal, Notice of	() Oral Hearing Req./Confirm.
() Assignment	() Petition to Extend Time
() Brief (in triplicate)	() Pet. under 37 C.F.R.
(X) Declaration XXXXXXX (unexecuted)	() Power of Attorney
() Design Application	____ Associate ____ w/Revocation
() Disclaimer	() Sequence Listing w/Computer
() Disclosure Statement	Readable and Paper Copies
() w/refs. () w/o refs.	() Small Entity Statement
() Drawings Formal	() Status Letter
____ Sheets ____ Figures	(X) Transmittal Letter for Utility Patent
	Application

Other: return postcard

File No. 9842-254-999

Sender: GSW/SSS/yc

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(b))</i>	Attorney Docket No.	9842-254-999	Total Pages	
	First Named Inventor or Application Identifier			
	Chung			
	Express Mail Label No.	EL 451 596 455 US		

APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents.</i>	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
1. <input checked="" type="checkbox"/> Fee Transmittal Form <i>Submit an original, and a duplicate for fee processing</i> 2. <input checked="" type="checkbox"/> Specification [Total Pages <u>16</u>] <i>(preferred arrangement set forth below)</i> -Descriptive title of the Invention -Cross Reference to Related Applications -Statement Regarding Fed sponsored R&D -Reference to Microfiche Appendix -Background of the Invention -Brief Summary of the Invention -Brief Description of the Drawings <i>(if filed)</i> -Detailed Description of the Invention <i>(including drawings, if filed)</i> -Claim(s) -Abstract of the Disclosure 3. <input checked="" type="checkbox"/> Drawing(s) <i>(35 USC 113)</i> [Total Sheets <u>6</u>] 4. <input checked="" type="checkbox"/> Oath or Declaration (unexecuted) [Total Sheets <u>3</u>] a. <input type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 CFR 1.63(d)) <i>(for continuation/divisional with Box 17 completed)</i> <i>[Note Box 5 below]</i> i. <input type="checkbox"/> <u>DELETION OF INVENTORS(S)</u> Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33 (b). 5. <input type="checkbox"/> Incorporation By Reference <i>(useable if Box 4b is checked)</i> The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.	6. <input type="checkbox"/> Microfiche Computer Program <i>(Appendix)</i> 7. <input type="checkbox"/> Nucleotide and/or Amino Acid Sequence Submission <i>(if applicable, all necessary)</i> a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy <i>(identical to computer copy)</i> c. <input type="checkbox"/> Statement verifying identity of above copies
ACCOMPANYING APPLICATION PARTS	
8. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) 9. <input type="checkbox"/> 37 CFR 3.73(b) Statement <input type="checkbox"/> Power of Attorney <i>(when there is an assignee)</i> 10. <input type="checkbox"/> English Translation Document <i>(if applicable)</i> 11. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations 12. <input type="checkbox"/> Preliminary Amendment 13. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) <i>(Should be specifically itemized)</i> 14. <input checked="" type="checkbox"/> Applicant claims Small Entity Status, see 37 C.F.R. 1.27 15. <input type="checkbox"/> Certified Copy of Priority Document(s) <i>(if foreign priority is claimed)</i> 16. <input type="checkbox"/> Other:	

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: filed .

18. CORRESPONDENCE ADDRESS

☒ Customer Number or Bar Code Label
 24341  Insert Customer No. or Attach bar code label here
or ☐ Correspondence address below

NAME				
ADDRESS				
CITY		STATE		ZIP CODE
COUNTRY		TELEPHONE		FAX

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

PENNIE & EDMONDS LLP

COUNSELLORS AT LAW

1155 Avenue of the Americas

New York, N.Y. 10036-2711

(212) 790-9090

ATTORNEY DOCKET NO. 9842-254-999Date: March 26, 2001

Assistant Commissioner for Patents

Box PATENT APPLICATION

Washington, D.C. 20231

Sir:

The following utility patent application is enclosed for filing:

Applicant(s): *Chung et al.*

Executed on: unexecuted

Title of Invention: INCLUSION OF NITROGEN AT THE SILICON DIOXIDE-SILICON CARBIDE INTERFACE FOR PASSIVATION OF INTERFACE DEFECTS

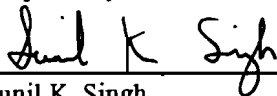
PATENT APPLICATION FEE VALUE

TYPE	NO. FILED	LESS	EXTRA	EXTRA RATE	FEE
Total Claims	26	-20	6	\$18.00 each	\$ 108.00
Independent	2	-3	0	\$80.00 each	\$ 0.00
Minimum Fee					\$ 710.00
Multiple Dependency Fee If Applicable (\$270.00)					\$ 0.00
Total					\$ 818.00
50% Reduction for Independent Inventor, Nonprofit Organization or Small Business Concern (a verified statement as to the applicant's status is attached)					- \$ 409.00
Total Filing Fee					\$ 409.00

- ☒ **DO NOT PUBLISH.** I hereby certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral agreement, that requires publication at eighteen months after filing. I hereby request that the attached application not be published under 35 U.S.C. 122(b).
- ☒ Priority of application no. 60,192,009 filed on March 24, 2000 in is claimed under 35 U.S.C. § 119.
- ☐ The certified copy of the priority application has been filed in application no. filed
- ☐ Amend the specification by inserting before the first line the following sentence: This is a continuation-in-part of application no. filed .

Please charge the required fee to Pennie & Edmonds LLP Deposit Account No. 16-1150. A copy of this sheet is enclosed.

Respectfully submitted,



Sunil K. Singh
PENNIE & EDMONDS LLP

for Gary S. Williams (Reg. No. 31,066)

45,298

(Reg. No.)

Enclosure

This form is not for use with continuation, divisional, re-issue, design or plant patent applications.

DECLARATION FOR NON-PROVISIONAL PATENT APPLICATION*

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below at 201 et seq. beneath my name.

I believe I am the original, first and sole inventor if only one name is listed at 201 below, or an original, first and joint inventor if plural names are listed at 201 et seq. below, of the subject matter which is claimed and for which a patent is sought on the invention entitled

INCLUSION OF NITROGEN AT THE SILICON DIOXIDE-SILICON CARBIDE INTERFACE FOR PASSIVATION OF INTERFACE DEFECTS

and for which a patent application:

☒ is attached hereto and includes amendment(s) filed on *(if applicable)*

☐ was filed in the United States on as Application No. *(for declaration not accompanying application)*

with amendment(s) filed on *(if applicable)*

☐ was filed as PCT international Application No. on and was amended under PCT Article 19 on *(if applicable)*

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED PRIOR TO THE FILING DATE OF THE APPLICATION			
APPLICATION NUMBER	COUNTRY	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES <input type="checkbox"/> NO <input type="checkbox"/>
			YES <input type="checkbox"/> NO <input type="checkbox"/>
			YES <input type="checkbox"/> NO <input type="checkbox"/>

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

PROVISIONAL APPLICATION NUMBER	FILING DATE
60/192,009	March 24, 2000

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

NON-PROVISIONAL APPLICATION SERIAL NO.	FILING DATE	STATUS		
		PATENTED	PENDING	ABANDONED

INCLUSION OF NITROGEN AT THE SILICON DIOXIDE-SILICON CARBIDE INTERFACE FOR PASSIVATION OF INTERFACE DEFECTS

This application claims the benefit under 35 U.S.C. § 119 (e) of United States Provisional Application No. 60/192,009, filed March 24, 2000, which is incorporated herein by reference in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

This invention was made with government support under grant # MDA972 98-1-0007 awarded by the Defense Advanced Research Projects Agency (DARPA). The
5 federal government has certain rights in the present invention.

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

10 The present invention relates to silicon carbide semiconductor devices and methods for their construction. More specifically, the instant invention relates to silicon carbide semiconductor devices with a layer of silicon dioxide disposed on a silicon carbide substrate that have a region of substantial nitrogen concentration at the silicon dioxide-silicon carbide interface.

15

2. DESCRIPTION OF THE RELATED ART

Presently, the silicon (Si) metal-oxide-semiconductor field effect transistor (MOSFET) is the most commonly manufactured transistor in the world. Silicon carbide (SiC) MOSFETS are currently being developed because of superior material
20 properties that provide high power generation, conditioning, transmission and the ability to operate at higher temperatures.

Like Si, SiC thermally oxidizes to form SiO₂. However, the oxidation kinetics and oxide interface of SiC are poorly understood in comparison to Si. The oxidation rate of SiC is lower than Si by more than a factor of 10. Furthermore, the quality of
25 the SiO₂/SiC interface is also inferior to the SiO₂/Si interface. This problem causes

DECLARATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or the below named inventors are the original, first and joint inventors (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **"INCLUSION OF NITROGEN AT THE SILICON DIOXIDE-SILICON CARBIDE INTERFACE FOR PASSIVATION OF INTERFACE DEFECTS,"** the Specification of which:

- ☐ is attached hereto.
☒ was filed on **March 26, 2001** as Application Serial No. **09/818,913**.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability of the subject matter claimed in this application, as "materiality" is defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent, United States provisional application(s), or inventor's certificate listed below and have also identified below any foreign application for patent, United States provisional application, or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIORITY APPLICATION(S)			Priority Claimed
60/192,009	United States of America	March 24, 2000	Yes
(Number)	(Country)	(Date Filed)	Yes/No
(Number)	(Country)	(Date Filed)	Yes/No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose all information known to me to be material to patentability of the subject matter claimed in this application, as "materiality" is defined in Title 37, Code of Federal Regulations, § 1.56, which become available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status)
(Application Serial No.)	(Filing Date)	(Status)

I hereby direct that all correspondence and telephone calls be addressed to **Randall C. Furlong, Ph.D., Williams, Morgan & Amerson, P.C., 7676 Hillmont, Suite 250, Houston, Texas 77040, (713) 934-4061.**

I HEREBY DECLARE THAT ALL STATEMENTS MADE OF MY OWN KNOWLEDGE ARE TRUE AND THAT ALL STATEMENTS MADE ON INFORMATION AND BELIEF ARE BELIEVED TO BE TRUE; AND FURTHER THAT THESE STATEMENTS WERE MADE WITH THE KNOWLEDGE THAT WILLFUL FALSE STATEMENTS AND THE LIKE SO MADE ARE PUNISHABLE BY FINE OR IMPRISONMENT, OR BOTH, UNDER SECTION 1001 OF TITLE 18 OF THE UNITED STATES CODE AND THAT SUCH WILLFUL FALSE STATEMENTS MAY JEOPARDIZE THE VALIDITY OF THE APPLICATION OR ANY PATENT ISSUED THEREON.

Inventor's Full Name: Gilyong Chung
 Inventor's Signature: *Gilyong Chung*
 Country of Citizenship: South Korea Date: 9/4/01
 Residence Address: (street, number, city, state, and/or country) 17710 Hampshire Oak Dr.
Tampa, FL, 33647
 Post Office Address: Same
 (if different from above)

Inventor's Full Name: Chin Che Tin
 Inventor's Signature: *Chin Che Tin*
 Country of Citizenship: Malaysia Date: 9/6/01
 Residence Address: (street, number, city, state, and/or country) 1428 Pinkston Ct.
Auburn, AL 36830
 Post Office Address: Same
 (if different from above)

Inventor's Full Name: John R. Williams
 Inventor's Signature: *John R. Williams*
 Country of Citizenship: USA Date: 9/6/01
 Residence Address: (street, number, city, state, and/or country) 54 Lee Road 48
Opelika, AL 36849
 Post Office Address: Same
 (if different from above)

Inventor's Full Name: Kyle McDonald

Inventor's Signature: _____

Country of Citizenship: U.S.A.

Date: _____

Residence Address: (street,
number, city, state, and/or
country)

2000 24th Avenue South, #66

Nashville, TN 47212

Post Office Address:
(if different from above)

Same

Inventor's Full Name: Massimiliano Di Ventra

Inventor's Signature: Massimiliano Di Ventra

Country of Citizenship: Italy

Date: 08-20-01

Residence Address: (street,
number, city, state, and/or
country)

12700 Foxridge LN NW, Apt #K

Blacksburg, VA 24060

Post Office Address:
(if different from above)

Same

Inventor's Full Name: Robert A. Weller

Inventor's Signature: _____

Country of Citizenship: U.S.A.

Date: _____

Residence Address: (street,
number, city, state, and/or
country)

1008 Green Hill Cov.

Brentwood, TN 37027

Post Office Address:
(if different from above)

Same

Inventor's Full Name: Sokrates T. Pantelides

Inventor's Signature: _____

Country of Citizenship: U.S.A.

Date: _____

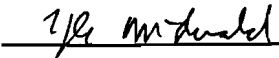
Residence Address: (street,
number, city, state, and/or
country)

4566 Peytonsville Road

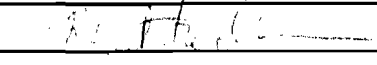
Franklin, TN 37064

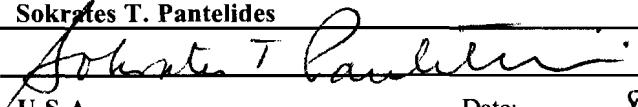
Post Office Address:
(if different from above)

Same

Inventor's Full Name: Kyle McDonald
Inventor's Signature: 
Country of Citizenship: U.S.A. Date: 8/21/01
Residence Address: (street, number, city, state, and/or country) 2000 24th Avenue South, #66
Nashville, TN 47212
Post Office Address: Same
(if different from above)

Inventor's Full Name: Max Di Ventra
Inventor's Signature: _____
Country of Citizenship: Italy Date: _____
Residence Address: (street, number, city, state, and/or country) 519 Tall Tree Lane
Nashville, TN 37209
Post Office Address: Same
(if different from above)

Inventor's Full Name: Robert A. Weller
Inventor's Signature: 
Country of Citizenship: U.S.A. Date: 8/17/01
Residence Address: (street, number, city, state, and/or country) 1008 Green Hill Cov.
Brentwood, TN 37027
Post Office Address: Same
(if different from above)

Inventor's Full Name: Sokrates T. Pantelides
Inventor's Signature: 
Country of Citizenship: U.S.A. Date: 8/16/01
Residence Address: (street, number, city, state, and/or country) 4566 Peytonsville Road
Franklin, TN 37064
Post Office Address: Same
(if different from above)

Inventor's Full Name:

Leonard C. Feldman

Inventor's Signature:

Leonard C. Feldman

Country of Citizenship:

U.S.A.

Date:

8.16.01

Residence Address: (street,
number, city, state, and/or
country)

1309 Gatewood Drive

Nashville, TN 37215

Post Office Address:
(if different from above)

Same

Please indicate receipt of the below-identified paper:

<input type="checkbox"/> New Application For:	Priority Date:
<input type="checkbox"/> Foreign priority already claimed	<input type="checkbox"/> Nonpublication Request
<input type="checkbox"/> Continuation	<input type="checkbox"/> Divisional
<input type="checkbox"/> Specification: Pages SEP 24 2001	<input type="checkbox"/> Drawings: Sheets
<input type="checkbox"/> Response to Office Action Dated:	<input type="checkbox"/> Final Rejection
<input checked="" type="checkbox"/> Other: Request for 2-month Extension of Time; Response to Notice to File Missing Parts, Declarations, Power of Attorney's, Assignments and Assignment Coversheet; Small Entity Fee; Change of Correspondence Address; copy of NTFMP; Postcard	
<input checked="" type="checkbox"/> Assignment Enclosed	<input checked="" type="checkbox"/> Cert. of Timely Mailing
	<input type="checkbox"/> Exp. Mail:

IDENTIFICATION OF APPLICATION

Serial No.:	09/818,913
Title:	INCLUSION OF NITROGEN AT THE SILICON DIOXIDE-SILICON CARBIDE INTERFACE FOR PASSIVATION OF INTERFACE DEFECTS
Applicant:	Chung et al.
Client:	Vanderbilt University
Mailed:	09/19/01
Filed:	03/26/01
Attorney:	RCF
File No.:	2026.000900
Due Date:	09/19/01